NATIONAL INDUSTRIAL SYMBIOSIS PROGRAM

MODEL FEASIBILITY STUDY FOR CANADIAN ADAPTATION

Prepared by Light House Sustainable Building Centre
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AUTHORSHIP

Light House Team
Tracy Casavant, Director, Resource Innovation
Katherine Bergeron, Social Impact Coordinator
Krista Funes, Industrial Symbiosis Research Volunteer
Sarah Goble, Industrial Symbiosis Research Volunteer

ACKNOWLEDGEMENTS

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Luke Smeaton, Executive Director, Light House
Ted Sheldon, Clean Energy Advisory, BC Ministry of Energy & Mines
Nadine Diner, Director of Industry Initiatives, Industry and Innovation Group, BC Innovation Council
EXECUTIVE SUMMARY

The National Industrial Symbiosis Program (NISP) model was developed and first delivered in the UK, starting in 2005. Having completed their own due diligence, more than 20 countries have now implemented the model. The objectives of this feasibility study are to evaluate the NISP model and to determine the viability of applying the NISP model in Canada.

What is Industrial Symbiosis?

Industrial symbiosis refers to business-to-business relationships that mimic symbiotic relationships between organisms in nature, where ‘waste equals food’. In practice, industrial symbiosis involves the waste of one or more businesses (or similar operations, such as a municipal wastewater treatment plant) being diverted to become an input to one or more other businesses. Symbiosis can occur between businesses in the same sector or businesses from different sectors.

What is the ‘NISP’ Model?

The National Industrial Symbiosis Program (NISP) model was developed in the UK in 2005. The NISP model has delivered documented, significant environmental, social and economic benefits. There are now programs based on the NISP model running more than 20 countries. The NISP model relies on facilitated industrial symbiosis. The model has four distinct components:

- Facilitated workshops, rather than technical studies, are used to identify industrial symbiosis opportunities;
- Synergie™, an information technology (IT) platform, supports practitioners and ensures that all benefits are accurately quantified.
- Locally-based practitioners, trained to international NISP protocol are dedicated to nurturing industrial symbiosis opportunities from idea to implementation.
- No cost to businesses’ participation – businesses can participate in workshops and utilise the services of the NISP practitioners free of charge.

Figure ES1: NISP model workshops (Egypt – right, France – left)
NISP-CANADA: FEASIBILITY CONCLUSION

The NISP Model is Feasible

The NISP model has been independently evaluated; independently audited; and proven to be adaptable, as it is now operating in more than 20 countries. The feasibility of the NISP model has been well-demonstrated internationally.

The NISP model supports Canada’s national and international policy goals.

The verified success, and proven flexibility and adaptability indicates that NISP should be as feasible in the Canadian context as it has proven successful in the 20 other jurisdictions to-date.

The NISP model has been independently evaluated. It has been identified by several organizations, including the Global Green Growth Forum, EC Directorate General for the Environment, and World Wildlife Fund, as being one of the top international best practices for achieving resource efficiency and fostering sustainable business activity.

The NISP model has been independently audited. The NISP model has proven, measurable benefits such as reducing greenhouse gases, reducing waste materials to landfill, strengthening businesses competitiveness, creating jobs, and building skills and capacity to support a circular, low carbon economy. Its methodologies for calculating the benefits from implemented symbiosis opportunities has been verified, and the scale of benefits achieved in the UK has been confirmed. The auditors verified the NISP-UK reported benefits from 2005-2010, and also modeled the long-term impact from the symbiosis opportunities implemented during that time i.e., a savings of 100 tonnes per year achieved in year 4 would continue to provide benefits in subsequent years. Two separate long-term models were created: Scenario 1 assumed persistence with 20% decay (diminishing benefits) per year, while Scenario 2 assumed persistence with 0% decay per year. Neither scenario considered the additional implementation of new symbiosis opportunities still ‘in the pipeline’ as of 2010. Selected audit results are shown in Table ES1, below:

Table ES1: NISP-UK 2005-2010 Audited Results

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<thead>
<tr>
<th>NISP-UK Delivered Outcomes 2005-2010</th>
<th>Actual Benefits 2005-2010</th>
<th>Lifetime Benefits Scenario 1</th>
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<td>Landfill diversion</td>
<td>7.0 million tonnes</td>
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The NISP model has **proven to be adaptable**, with initiatives based on the model now running in 21 countries. As the NISP network has grown, the framework has proven itself adaptable to different geographies and financial models. NISP has proved its flexibility to being adapted to many contexts, with varying geographical or financial conditions. For example, in Holland where there is only one central industrial region, NISP becomes a singular regional program, whereas in Turkey, with multiple industrial regions under largely national control, an expansive program was rolled-out in a short-period of time, regionally delivered and nationally funded and orchestrated. Holland funds the program solely on government funds, whereas Belgium is half funded by government and the chemical industry.

The NISP model **supports Canada’s national and international policy commitments**. Therefore, the Canadian government, and, provincial and municipal governments, should support the establishment of a NISP in Canada. The NISP model supports several of the federal governments targets related to goals for tackling climate change and advancing clean technology outlined in the Draft Federal Sustainable Development Strategy. The NISP model also supports Canada’s international commitments made under COP21, the G7 (via its Alliance for Resource Efficiency) and the United Nations Sustainable Development Goals.

**NISP Model: Considerations for Canadian Adaptation**

The Canadian context does raise some unique organizational questions that must be answered before the model can be readily replicated in regions across Canada. These questions, and a possible plan for addressing them, are presented below. Given the nature of the questions, and the challenges in general with respect to national co-ordination across a federation structure, we recommend that NISP be adapted to Canada in two or more regional pilots first. Such pilots would help to answer these questions, and would shape a ‘Made in Canada’ NISP initiative.

**HOW BIG IS A ‘REGION’?**

A metropolitan area? A province? It is not clear how far and wide the generally minimum two regional practitioners could reach. It is also not clear how far businesses would travel to attend a workshop, or at what scale geography begins to present a common barrier to an otherwise viable symbiosis business case. Any pilots will seek to provide a better understanding of business participation rates and businesses’ need for practitioner assistance in advancing the symbiosis opportunities identified at the workshop.

**HOW MANY AND WHAT REGIONS ARE DESIRABLE FOR A NATIONAL PROGRAM?**

The UK program was ultimately delivered across the whole of England in 13 regions, following the boundaries of its regional economic development authorities. Falling out of the unknowns related to the required size of a Canadian region, it’s not known how many regions should be included in a Canadian national program. For example, should a ‘national’ program in Canada focus on the metropolitan areas around cities represented by the Big City Mayors’ Caucus, or include other regions as well?
WHAT ARE THE OPTIONS FOR FINANCING THE PROGRAM?

The international precedent is generally for the majority of funding/investment to come from national (or EU) government sources. In the short to medium term, investing in a ‘NISP-Canada’ is an attractive value proposition for policy makers/governments who are already investing significant amounts to achieve the combined aims of job creation, growth, innovation, competitiveness, and greenhouse gas emission reduction.

Long-term, it is not likely politically palatable for a NISP-Canada to be primarily funded by the federal government. Long term funding will be greatly influenced by the results of any pilot. For example, it’s possible that, like Belgium, certain sectors see great success and those associations are therefore incentivized to fund the program long term. Alternative finance mechanisms should also be explored, such as green bonds, social impact bonds, and the establishment of a trust into which a portion of companies’ savings from implementing symbiosis could be deposited and used to sustain the program.

The European Commission’s Directorate General for the Environment commissioned a report in 2011 that, while endorsing the NISP model, did note that scaling could be affected by limited funds (Economic Analysis of Resource Efficiency Policies, 2011, see also Appendix G). Should Canada be able to develop some alternative funding models, there would likely be significant international interest in learning from and adapting these models to other NISP initiatives.

It should also be noted that, to secure government funding, both the Canadian and provincial contexts would likely require NISP to be housed within a not-for-profit entity. However, this should also be confirmed during any pilot.

HOW DO THE BENEFITS SEEN IN THE UK SCALE TO A CANADIAN REGION?

And what might that mean for benefits in other regions in Canada? The geographic, regulatory, and economic landscape is not only unique at the national scale, but also varies regionally as well. It’s not known how the benefits scale to regions with less heavy industry, or what the influence is, if any, of policies such as a carbon tax or strong extended producer responsibility legislation.

In conclusion, while it is most certainly feasible to apply the NISP model in the Canadian context, there are some considerations that may shape the final form of any NISP-Canada. Regional pilots would help to answer outstanding questions. The answers to these questions will: maximize the success of a regional model; shape a sustainable, multi-region “Made-in-Canada” program; and provide yet another valuable case study to the growing number of countries exploring how best to adopt NISP to meet their national and local sustainable business objectives.
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F. Global Green Growth Forum (3GF) Industrial Symbiosis Partnership Documents
H. Circular Economy in Europe: Developing The Knowledge Base
I. Overview of NISP Alignment with Canada’s Draft Federal Sustainable Development Strategy
J. G7 Annex to the Leaders’ Declaration, 2015, and G7-Alliance For Resource Efficiency Industrial Symbiosis Workshop Proceedings, 2015
INTRODUCTION

Industrial symbiosis refers to business-to-business relationships that mimic symbiotic relationships between organisms in nature, where ‘waste equals food’. In practice, industrial symbiosis involves the waste of one or more businesses (or similar operations, such as a municipal wastewater treatment plant) being diverted to become an input to one or more other businesses. Over time, industrial symbiosis has evolved to include the diversion of waste liquids (including water) and waste energy flows, and has also supported business-to-business collaborations around more intangible resources such as transportation or human resource needs. Symbiosis can occur between businesses in the same sector or businesses from different sectors.

“Industrial symbiosis is a solution ready to be scaled. It has been estimated by International Synergies Limited, the partnership hosts, that the potential global impact of large scale industrial symbiosis could be around US$7.7 billion per annum from an annual investment of only US$213 million.”

Global Green Growth Forum

The National Industrial Symbiosis Program (NISP) model was developed and first delivered in the UK, starting in 2005. Having completed their own due diligence, more than 20 countries have now implemented the model.

The objectives of this feasibility study are to evaluate the NISP model and to determine the viability of applying the NISP model in Canada.

The feasibility study comprises three parts:

I. Industrial Symbiosis Models

II. Summary of Existing NISP Evaluations & Policy: Review of existing international evaluations and policies advancing industrial symbiosis and related to the NISP model; and

III. NISP-Canada Feasibility Considerations: Implications of international best practice on adapting the NISP model to Canada.
INDUSTRIAL SYMBIOSIS MODELS

Summary of Model Types

Industrial symbiosis (IS) can be catalysed in four key ways: serendipity; passive engagement; data-driven; and facilitated. Table 1 explains each model.

Table 1: Industrial Symbiosis Model Types

<table>
<thead>
<tr>
<th>Model Type</th>
<th>Serendipity</th>
<th>Passive Engagement</th>
<th>Data-Driven</th>
<th>Facilitated</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td>Isolated examples of industrial symbiosis that was implemented by two businesses with no external help e.g., the businesses met by chance and recognized a specific opportunity.</td>
<td>Waste exchange databases that allow businesses to enter their waste materials and / or search for input replacements. Sometimes supported by a co-ordinator who keeps an eye open for opportunities, or who might connect businesses to resources needed to implement the transaction e.g., a transportation company.</td>
<td>Third-parties visit companies and collect data via surveys, interviews, and waste audits. The third-parties then review the data to look for opportunities. Businesses are provided with just the recommendations, or the third-party is resourced enough to spend time trying to convince the businesses to implement them.</td>
<td>Businesses are engaged as a group, such as in a workshop, where a facilitator helps to identify potential symbiosis opportunities by drawing out businesses’ resource stream haves and wants. Facilitators then follow-up with businesses to help them implement the opportunities.</td>
</tr>
<tr>
<td><strong>Example</strong></td>
<td>Vancouver Landfill and CanAgro Greenhouses Agricultural Waste to FortisBC Renewable Natural Gas</td>
<td>BC IMEX (Industrial Materials Exchange)</td>
<td>Partners in Project Green Alberta Industrial Heartland Waste Heat Mapping</td>
<td>Kwinana Industries Council (Australia) Western Cape Industrial Symbiosis Program, S Africa (NISP model)</td>
</tr>
<tr>
<td>Model Type</td>
<td>Serendipity</td>
<td>Passive Engagement</td>
<td>Data-Driven</td>
<td>Facilitated</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------</td>
<td>--------------------</td>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td><strong>Advantages</strong></td>
<td>No external costs are incurred.</td>
<td>Low operational costs, once database is developed.</td>
<td>Detailed business cases can be developed relatively early in the process. An objective third-party visiting businesses can help to build capacity and support around symbiosis and related sustainability goals.</td>
<td>Results in the highest number of symbiosis opportunities identified and implemented. An objective third-party visiting businesses can help to build capacity and support around symbiosis and related sustainability goals.</td>
</tr>
<tr>
<td><strong>Disadvantages</strong></td>
<td>While such examples are inspirational and may lead to symbiosis opportunities, they do not lead to the systematic embedding of industrial symbiosis in a region.</td>
<td>Most businesses do not have the time or inclination to search the database and then follow-up with the respective company. The information in the database is often technically incomplete and out of date. There are also problems with classifications of materials.</td>
<td>Relatively costly and time-consuming related to the amount of symbiosis implemented. The studies often ‘sit on shelves’ because the process did not build a relationship between the businesses or the opportunity did not solve a top operational challenge for them.</td>
<td>Highest absolute costs, although most-cost-effective in terms of the number of symbiosis opportunities identified and implemented, and the mass of resources diverted.</td>
</tr>
</tbody>
</table>
NISP Model

Overview

As this feasibility study was designed to explore the feasibility of adapting to Canada facilitated symbiosis as represented in the NISP model, a more detailed description of the NISP model is presented here. Developed in the UK in 2005 the NISP model has delivered tremendous environmental, social and economic benefits. It is now established and adapted to regions in over 20 countries and counting. The model is built around the principle of engaging people (representing businesses) first, and then providing personal support to advance their symbiosis opportunities. The model has four distinct components:

- Facilitated workshops, rather than technical studies, are used to identify industrial symbiosis opportunities;
- Synergie™, an information technology (IT) platform developed just for the NISP model, supports practitioners and ensures that all benefits are accurately quantified.
- Locally-based practitioners, trained to international NISP protocol and guided by a business-focused Regional Advisory Committee, are dedicated to nurturing industrial symbiosis opportunities from idea to implementation.
- No cost to businesses’ participation – businesses can participate in workshops and utilise the services of the NISP practitioners free of charge.

Facilitated Workshops

NISP uses a facilitated process to bring about industrial symbiosis, engaging businesses from the outset via workshops that are facilitated by locally-based practitioners trained according to international NISP protocol. Based on the NISP model, the workshop agenda would generally be as follows, using a start time of 8:00 AM:

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00</td>
<td>Networking, Registration, Coffee</td>
</tr>
<tr>
<td>8:30</td>
<td>Opening address (standard overview presentation tailored to local context)</td>
</tr>
<tr>
<td>9:00</td>
<td>Guest speaker(s) (usually local business champions already practising industrial symbiosis; government supporters, etc.)</td>
</tr>
<tr>
<td>9:20</td>
<td>Detailed workshop instructions</td>
</tr>
<tr>
<td>9:30</td>
<td>Coffee break</td>
</tr>
<tr>
<td>9:50</td>
<td>Haves, Wants &amp; Synergies Working session facilitated according to international protocol License includes all training materials, handouts, etc. Frequently, local business champions also receive training ahead of the workshop to provide facilitation support at the working tables.</td>
</tr>
<tr>
<td>11:30</td>
<td>Networking, lunch During this time, workshop facilitators (i.e., the local practitioners) review working session outcomes.</td>
</tr>
<tr>
<td>12:30</td>
<td>Closing Message</td>
</tr>
</tbody>
</table>
Ahead of the workshop, businesses are provided with a Workshop Preparation handout to prompt them to begin thinking about resources they have and resources they want. “In the context of Industrial Symbiosis, it is important that ‘resources’ are recognised in their broadest context. There is a natural tendency to think about waste….Your outputs may not be waste-related, but could easily be available resources that you can supply to another company as part of an ongoing agreement.” Businesses are also provided with a worksheet so that they can brainstorm ahead of time what resources they have/need. The worksheet breaks resources down into the following categories: Materials, Capacity, Energy, Land, Logistics, Water, Expertise.

Based on existing NISP programs, an average workshop with 40 attendees results in 400 opportunities, about 40 of which are implemented with the support of a practitioner, and others implemented by businesses without any assistance. At an average of 4 workshops per year per region, the model embeds industrial symbiosis far deeper and more quickly than other approaches such as waste exchange databases or audit-driven programs. Photos showing 2016 workshops in France (left) and Egypt (right) are presented in Figure 1, below.

![Figure 1: NISP Workshop Photos (Source: International Synergies Ltd.)](image)

**Synergie™ Platform**

Immediately following the workshop, the practitioners enter the workshop outcomes into Synergie™. This data includes information about the businesses as well as their haves, wants, and synergy matches made during the workshop. The practitioners then produce a Workshop Outcome Report and circulate it to participants and supporters. Synergie™ also ensures that the performance of every symbiosis opportunity is quantified, with an ability to calculate indicators such as jobs created, greenhouse gas emissions reduced, or solid waste diverted. These calculations support the development of case studies. Furthermore, Synergie™ serves as a growing database of available resources for practitioner to...
reference throughout the life of the pilot and program. Selected screenshots of the Synergie® software are shown in Figure 2.

![Synergy ID Table]

<table>
<thead>
<tr>
<th>Synergy ID</th>
<th>Name</th>
<th>Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td>James' Food - Woodcock Recycling - Vegetables</td>
<td>Idea</td>
</tr>
<tr>
<td>30</td>
<td>James pallets - Woodcock Recycling - Pallets</td>
<td>Negotiation</td>
</tr>
<tr>
<td>27</td>
<td>Liesel Construction - Woodcock Recycling - Pallets</td>
<td>Idea</td>
</tr>
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![Completed Synergies Table]

<table>
<thead>
<tr>
<th>Synergy ID</th>
<th>Name</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>Rogers Paper - Banner Paper - Paper</td>
<td>24/06/2015</td>
</tr>
<tr>
<td>37</td>
<td>James Water - Woodcock water -</td>
<td>04/12/2014</td>
</tr>
</tbody>
</table>

![Synergies Completed Per Month]

**Figure 2: Selected Synergie™ Screenshots**

A sample Workshop Outcome Report is attached in Appendix A. A sample Program Outcome Report is attached in Appendix B. Selected Case Studies may be found in Appendix C.
Dedicated Practitioners & Regional Advisors

Then, the dedicated practitioners begin following up on the potential synergies, tracking them in Synergie™ from Idea, to Discussion, to Feasibility, to Negotiation, to Implementation. The dedicated practitioners are critical to the NISP model, and are responsible both for the high idea generation through their facilitation of NISP workshops, as well as for the conversion of ideas into implemented projects. The presence of dedicated practitioners helps to overcome a common barrier, especially within SMEs, related to the availability of time or technical capacity needed to implement a multi-business symbiosis project.

The efforts of the dedicated practitioners are usually supported a Regional Advisory Committee (RAC), comprising primarily regional business sector representatives, plus other government and academic representatives depending on the country’s political structure, program funding model, and regional priorities. As one workshop generally produces 10x the opportunities as the number of participants, the RAC can support the practitioner in determining how to prioritise follow-up. For example, based on its knowledge of the regional economy and priorities, a RAC might determine that the dedicated NISP practitioners focus on symbiosis opportunities that involve clean tech innovation, create the most jobs, or reduce carbon footprint. This structure was established to ensure that NISP delivery maximizes value to regional businesses.

The dedicated practitioners themselves are part of an international collaborative network of NISP practitioners that can share knowledge regarding symbiosis successes related to particular materials or business-types. For example, in a country with many regional programs, one region might have a practitioner with extra experience or expertise in a particular industry. That practitioner could provide support to other regional practitioner colleagues working to implement a symbiosis opportunity involving that industry.

No Cost Participation

This model delivers results due to the cost effective approach to businesses and the persistence of trained practitioners. Contrary to other industrial symbiosis models there are no initial auditing costs, the workshops are free to encourage participation particularly from SMEs (where charges are a barrier to entry) and practitioners achieve greater follow through than happenstance waste exchanges. In other countries, program delivery costs (practitioner salaries, training, software licenses, and general management and administration) are generally funded entirely from government sources. The program with the least amount of government funding is the program in Belgium, which is funded 50% by the national government, and 50% by the national chemical producers association. A discussion of the verified cost-benefit ratio for government investment in NISP is discussed as part of the review of the Pathway to a Low Carbon Economy audit report presented in the following section.
SUMMARY OF EXISTING EVALUATIONS & POLICY

Introduction

One of the most comprehensive evaluations of the NISP model was completed in 2010 by Scott Wilson Consultancy (‘Wilson’) and Manchester Economics (‘Manchester’). Wilson and Manchester completed a rigorous verification of the results claimed by the NISP-UK during its first five years of operation, and also evaluated the economic benefits to the UK Treasury, as the UK national government wholly invested in NISP-UK. The Wilson and Manchester findings are presented in the Pathway to a Low Carbon Economy Report, which is summarized in this section of the feasibility study.

In addition to the Pathway to a Low Carbon Economy, there have been additional evaluations of the NISP model that have influenced policy development, particularly within the EU, and have also led to other third-party endorsements of industrial symbiosis, especially as achieved via the NISP model.

This section provides an overview of the seminal Pathway to a Low Carbon Economy Report, as well as relevant policies and endorsements. Where possible, the original source materials have been appended to this feasibility study, as referenced at the start of each sub-section.

The Pathway to a Low Carbon Sustainable Economy, 2010

See Appendix D for the above report, including the Wilson and Manchester reports.

The first five years of the NISP-UK (2005-2010) were third-party audited, verifying impact on: greenhouse gas (GHG) reduction, waste diversion, fiscal performance, and job creation. The auditors verified the NISP-UK reported benefits from 2005-2010, and also modeled the long-term impact from the symbiosis opportunities implemented during that time i.e., a savings of 100 tonnes per year achieved in year 4 would continue to provide benefits in subsequent years. Two separate long-term models were created: Scenario 1 assumed persistence with 20% decay (diminishing benefits) per year, while Scenario 2 assumed persistence with 0% decay per year. Neither scenario considered the additional implementation of new symbiosis opportunities still ‘in the pipeline’ as of 2010.

Table 2: NISP-UK 2005-2010 Audited Results

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Government Return on Program Investment

The third-party audit of the NISP-UK program also calculated the cost-benefit ratio for the UK government’s investment of considered the following factors when determining the cost-benefit ratio to the UK Treasury:

- New corporate income tax revenues;
- New personal income tax revenues; and
- New value-added tax (VAT) revenues (Canada’s Goods & Services Tax is a VAT).

The cost: benefit ratio was calculated to be 32:1 to 53:1 depending on the decay assumptions used.

The net Total Economic Value Added (TEVA) also included benefits from indirect jobs and environmental TEVA, using methodology from Her Majesty’s Treasury Green Book, which provides “…guidance for public sector bodies on how to appraise proposals before committing funds to a policy, programme or project” (https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-government). The net TEVA multiplier ranged from 53.2 to 88.6, depending on the decay assumptions used.

Program Cost Effectiveness

The audit also found that the program became more cost-effective with time. For example, the cost (with respect to government investment) to divert one tonne of material from landfill was £0.58 in year one, but down to £0.15 in year five. The overall cost-effectiveness per metric is summarized in the table below. While the NISP was initiated primarily as a solid waste management initiative, the carbon reductions achieved, as well as the cost to the government for those reductions, were unexpected and significant outcomes.

Table 3: NISP-UK Cost-Effectiveness 2005-2010

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Proportional Cost to the Government 2005-2010</th>
<th>Proportional Lifetime Cost Scenario 1</th>
<th>Proportional Lifetime Cost Scenario 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>One tonne of waste diversion</td>
<td>56 pence</td>
<td>19 pence</td>
<td>11 pence</td>
</tr>
<tr>
<td>One tonne of CO2 reduced</td>
<td>65 pence</td>
<td>22 pence</td>
<td>13 pence</td>
</tr>
<tr>
<td>One tonne of virgin material saved</td>
<td>41 pence</td>
<td>14 pence</td>
<td>8 pence</td>
</tr>
<tr>
<td>One tonne of hazardous waste eliminated</td>
<td>£11</td>
<td>£4</td>
<td>£2</td>
</tr>
<tr>
<td>One tonne of water reduced</td>
<td>41 pence</td>
<td>14 pence</td>
<td>8 pence</td>
</tr>
<tr>
<td>One £ cost savings</td>
<td>3 pence</td>
<td>0.8 pence</td>
<td>0.5 pence</td>
</tr>
<tr>
<td>One £ additional sales</td>
<td>2 pence</td>
<td>0.7 pence</td>
<td>0.4 pence</td>
</tr>
</tbody>
</table>

Note: As of July 14, 2016, one British pound (100 pence) was equivalent to $1.72 CAD.

Additional Insight
The Pathway report presents some additional insights with respect to the NISP model. For example, the report notes that there were 60 practitioners across 13 regions, giving some indication of the scale of the operation. Furthermore, the report notes that in 5 years, 12,500 businesses were engaged, the majority of which were surprisingly small and medium-sized enterprises (SMEs). The report also introduces the role and importance of regional Program Advisory Committees comprising mainly business representatives. Lastly, the report underscores the diverse resource streams and business sectors that the program engaged.

**Green Game-Changing Innovation: New Business Thinking From Around the World, 2010**

This report may be found in Appendix E. See also http://assets.wwf.org.uk/downloads/greengamechange_report.pdf

The World Wildlife Fund-UK (WWF-UK) commissioned a study to highlight commercial innovations and show how companies are benefiting from sustainable business opportunities. The study was completed by Verdantix.

Following a market scan, 120 global innovations were identified. These were screened against the following criteria (p. 5):

- **Is it relevant?** Does the innovation provide significant benefits across one or more dimensions of environmental sustainability: energy efficiency, the decarbonisation of energy, water efficiency, ecosystem health (or services)? Has it achieved some adoption already, or is it close to reaching the market?

- **Does it have the potential to be game-changing?** Is it scalable with the potential to achieve a high level of market adoption? Is it likely to achieve lasting adoption? Is it sufficiently different in nature from existing market offerings? Does it have the potential for a high commercial impact? Could it change the competitive landscape? Could it alter existing markets and create new ones?

Facilitated industrial symbiosis, as represented by NISP-UK was ranked one of the top 20 global innovations for business sustainability. The report notes that “...Industrial symbiosis programmes can facilitate partnerships that generate mutual value and improvements in resource efficiency, cost savings and new revenue. ...This model is applicable worldwide.”

**Global Green Growth Forum (3GF) Industrial Symbiosis Partnership**

The 3GF Industrial Symbiosis Partnership reports may be found in Appendix F.

The Danish Government, supported by the Governments of Korea and Mexico, established the 3GF in 2011, to demonstrate how public and private sector collaboration could drive long-term green growth. The current Advisory Board is listed below:

- Seunghoon Lee, Co-Chair of the Green Growth Committee of the Government of the Republic of Korea
The 3GF established an Industrial Symbiosis partnership at its 2013 forum. It notes:

"Industrial symbiosis is a key driver of green growth. It has been recognised across the world for its contribution to the circular economy through green growth, eco-innovation, job creation and resource efficiency. The vision shared by 3GF’s IS PPP partners is to deliver a model of IS that works at scale, integrating within and across country boundaries to optimise the potential for IS to address global agendas."

The Industrial Symbiosis partnership has estimated that global scale-up of the NISP model could generate around $7.7 billion USD per annum in benefits from an estimated annual investment of only $213 million USD.

The Industrial Symbiosis partnership was instrumental in successfully lobbying the G7 to establish its Alliance for Resource Efficiency at the 2015 G7 Summit. The Industrial Symbiosis partnership has also supported the launch of NISPs, such as the Western Cape Industrial Symbiosis Program in South Africa, and convened a 3GF Regional Conference in Africa in 2015, with a focus on emerging industrial symbiosis activity in Africa. Subsequently a European Switch Africa Green project is supporting industrial symbiosis in South Africa, Kenya, Ghana, Burkina Faso, Mauritius and Uganda whereas the African Development Bank is supporting such work in Egypt.
Economic Analysis of Resource Efficiency Policies, 2011

The full report may be found in Appendix G.

This report was commissioned by the European Commission Directorate General for Environment ("DG Environment") and prepared by COWI Consultants of Denmark, an 85-year old engineering, economics and environmental science consultancy with more than 6,000 employees. Their final report, titled “Economic Analysis of Resource Efficiency Policies” screened 120 programmes from 23 countries. Using evaluation criteria such as the scale of resource efficiency potential; sector coverage; resource coverage, nine programmes, including NISP, were selected for further analysis. NISP scored top for cost effectiveness, impact and replication potential across Europe and was said to provide “…the widest environmental and economic benefits” and “…optimises the use of resources”. The authors noted that NISPs success was supported by “… cross sectoral synergies between industries…” and “…backing of national funding…”. COWI also posited that “EU–wide network has the potential to be even more successful than NISP in England”, but noted that funding can be a limiting factor.

Based on the findings of this report, the EU funded NISP projects in Romania and Hungary. In Romania, the EU is provided 42% of a total €880 700 (~$1.28M CAD) funding required for a two-year regional program that ran from February 2009 to October 2011. In Hungary, the EU provided 50% of the €800 000 (~$1.16M CAD) costs for a three-year program that began in 2010.

Circular Economy in Europe: Developing the Knowledge Base, 2016

This report may be found in Appendix H.

This report was published February 2016 by the European Environment Agency, an agency of the European Commission. The report lists industrial symbiosis as a key enabling business model to advance the circular economy, with the NISP-UK presented as a case study.

The report is part of a larger European Action Plan for the Circular Economy, which will support the EU’s efforts to develop a sustainable, low carbon, resource efficient and competitive economy by protecting businesses against the scarcity of resources and volatile prices.

The Council of the European Union adopted conclusions for action for a circular economy that (June 2016):

(3) CONSIDERS the active involvement of the private sector and other stakeholders across Europe and at the global level a key element for a successful and more effective transition towards a Circular Economy; ENCOURAGES the EU and the Member States, at all levels of government, to actively engage the private sector to promote cooperation, innovation and industrial symbiosis projects within and across sectors and value chains; including by addressing specific challenges in the transition to the Circular Economy, through agreements between stakeholders in society and governments …
Canadian National & International Policy Alignment

**Draft Federal Sustainable Development Strategy, 2016**

A detailed document analysing the alignment of the NISP model with the Draft Strategy may be found in Appendix I.

The Draft Federal Sustainable Development Strategy (Draft FSDS) was tabled in 2016 to “...set the federal government’s environmental sustainability agenda for the next three years.” The Draft FSDS sets out a number of goals and targets under five overall headings, of which two, *Taking Action on Climate Change* and *Clean Technology, Jobs and Innovation* are particularly relevant to NISP.

The NISP model, and delivery of any ‘NISP-Canada’ will help the federal government achieve many of its goals and targets, especially with respect to *Taking Action on Climate Change*, and *Clean Technology, Jobs and Innovation*. For example, one of the *Taking Action on Climate Change* targets is “National Leadership on Climate Change: Relative to 2005 emission levels, reduce Canada’s total GHG emissions 17% by 2020 and 30% by 2030”, with a proposed initiative supporting “Voluntary sustainable development actions to reduce GHG emissions”. Based on international experience, a NISP-Canada could engage at least 120 businesses per year, per region in voluntary, profitable actions to reduce GHG emissions. The NISP model would provide businesses with a tried and tested tool, capable of benefiting their businesses while reducing GHG emissions.

As detailed in Appendix I, the NISP model appears to support 17 proposed initiatives corresponding to eight of the Draft FSDS targets.

**COP21, 2015**

The Pathway to a Low Carbon Economy Report (discussed at the start of this section) verified that industrial symbiosis as delivered through the NISP model reduces greenhouse gas emissions through six different methods:

1. Inputs: Lower embedded energy in processing recycled materials than extracting virgin raw materials
2. Processes Savings: in gas, electricity and other fuel use by synergy partners, principally through innovation
3. Fuels substitution: Replacing fossil fuels with other fuel sources in industrial processes
4. Transport Reduction: in transport directly related to implementation of local synergies
5. Disposal Reduction: in reducing biodegradable material sent to landfill
6. Energy Production: of energy through, for example, anaerobic digestion and utilisation of waste heat

The NISP model could help Canada work towards its international greenhouse gas emission reduction commitments in a manner that mobilizes the private sector and creates economic benefit for both the private and public sector (as outlined in the Pathway to a Low Carbon Economy report).
G7 Alliance for Resource Efficiency (G7-ARE), 2015

The Annex referencing the creation of the G7-ARE, as well as the G7-ARE Industrial Symbiosis Workshop Report may be found in Appendix J.

The Group of Seven (G7) represents the United States, Canada, France, Germany, Italy, Japan, and the United Kingdom. The G7 members meet formally on an annual basis to discuss and collaborate around global issues.

At its 2015 Summit, the G7 reaffirmed “...the high importance of the protection and efficient use of natural resources throughout their life cycle and the positive impact on all three equally important dimensions of sustainability – economic, environment and social aspects.” (Annex, p.8) and established a “...G7 Alliance on Resource Efficiency, which will provide a forum to exchange and promote best practices and foster innovation together with business (Business 7) and other stakeholders, including from the public sector, research institutions, academia, consumers and civil society, on a voluntary, non-binding basis” (Annex, p. 8).

The very first action of the G7-ARE was to convene an international Workshop on Industrial Symbiosis, held on October 29th/30th, 2015, in Birmingham, UK, the ‘birthplace’ of the NISP model. In recognition of the success of the NISP model, the G7-ARE invited the creator of the NISP model, Peter Laybourn of International Synergies Ltd., to develop the program and background materials for participants. As the meeting coincided with the transition period of the Canadian federal government, Canada was only able to send one participant as an observer. The goal of this gathering was to share best practices and to endorse and support the implementation of industrial symbiosis on an international scale.

United Nations Sustainable Development Goals

Industrial symbiosis supports several of the United Nations’ Sustainable Development Goals and targets:

Goal 8: Promote inclusive and sustainable economic growth, employment and decent work for all

Target: Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour intensive sectors

This target is supported by Industrial symbiosis as synergies among industries promote innovation that reduce the amount of raw materials used. Shifting towards increased product value and reparability also reduces consumption of goods and resources.

Target: Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services

Counterintuitively, there has been significant participation of SMEs in NISPs worldwide. The UK participation of SMEs is documented in the Pathways to a Low Carbon Economy report, which further found that 20% of implemented symbiosis opportunities involved some level of innovation.

Target: Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the
10-year framework of programmes on sustainable consumption and production, with developed countries taking the lead

This target is supported by Industrial symbiosis as synergies among industries promote innovation that reduce the amount of raw materials used. Shifting towards increased product value and reparability also reduces consumption of goods and resources.

**Goal 9: Build resilient infrastructure, promote sustainable industrialization and foster innovation**

**Target:** By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.

NISPs target existing industries; therefore, NISPs catalyse retrofit activities. The resulting symbiosis partnerships increase materials, energy, and/or water resource-efficiency. 20% of the resulting symbiosis partnerships involve some level of clean technology innovation.

**Goal 11: Make cities inclusive, safe, resilient and sustainable**

**Target:** By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management

NISP initiatives have been proven to significantly reduce the amount of solid waste requiring landfill; the use of hazardous wastes; industrial water consumption; energy consumption; and greenhouse gas emission generation. These impacts are on a regional or metropolitan area scale.
NISP-CANADA: FEASIBILITY CONCLUSION

The NISP Model is Feasible

The NISP model has been independently evaluated; independently audited; and proven to be adaptable, as it is now operating in more than 20 countries. The feasibility of the NISP model has been well-demonstrated internationally.

The NISP model supports Canadian policy goals and is feasible in the Canadian context.

The NISP model has been independently evaluated. It has been identified by several organizations, including the Global Green Growth Forum, EC Directorate General for the Environment, and World Wildlife Fund, as being one of the top international best practices for achieving resource efficiency and fostering sustainable business activity.

The NISP model has been independently audited. Its methodologies for calculating the benefits from implemented symbiosis opportunities has been verified, and the scale of benefits achieved in the UK has been confirmed. The NISP model has proven, measurable benefits such as reducing greenhouse gases, reducing waste materials to landfill, strengthening businesses competitiveness, creating jobs, and building skills and capacity to support a circular, low carbon economy.

The NISP model has proven to be adaptable, with initiatives based on the model now running in 21 countries. As the NISP network has grown, the framework has proven itself adaptable to different geographies and financial models. NISP has proved its flexibility to being adapted to many contexts, with varying geographical or financial conditions. For example, in Holland where there is only one central industrial region, NISP becomes a singular regional program, whereas in Turkey, with multiple industrial regions under largely national control, an expansive program was rolled-out in a short-period of time, regionally delivered and nationally funded and orchestrated. Holland funds the program solely on government funds, whereas Belgium is half funded by government and the chemical industry.

The NISP model supports Canada’s national and international policy commitments. Therefore, the Canadian government, and, provincial and municipal governments, should support the establishment of a NISP in Canada. The NISP model supports several of the federal governments targets related to goals for tackling climate change and advancing clean technology outlined in the Draft Federal Sustainable Development Strategy. The NISP model also supports Canada’s international commitments made under COP21, the G7 (via its Alliance for Resource Efficiency) and the United Nations Sustainable Development Goals.

The verified success, and proven flexibility and adaptability indicates that NISP should be as feasible in the Canadian context as it has proven successful in the 20 other jurisdictions to-date.
NISP Model: Considerations for Canadian Adaptation

The Canadian context does raise some unique organizational questions that must be answered before the model can be readily replicated in regions across Canada. These questions, and a possible plan for addressing them, are presented below. Given the nature of the questions, and the challenges in general with respect to national co-ordination across a federation structure, we recommend that NISP be adapted to Canada in two or more regional pilots first. Such pilots would help to answer these questions, and would shape a ‘Made in Canada’ NISP initiative.

HOW BIG IS A ‘REGION’?

A metropolitan area? A province? It is not clear how far and wide the generally minimum two regional practitioners could reach. It is also not clear how far businesses would travel to attend a workshop, or at what scale geography begins to present a common barrier to an otherwise viable symbiosis business case. Any pilots will seek to provide a better understanding of business participation rates and businesses’ need for practitioner assistance in advancing the symbiosis opportunities identified at the workshop.

HOW MANY AND WHAT REGIONS ARE DESIRABLE FOR A NATIONAL PROGRAM?

The UK program was ultimately delivered across the whole of England in 13 regions, following the boundaries of its regional economic development authorities. Falling out of the unknowns related to the required size of a Canadian region, it’s not known how many regions should be included in a Canadian national program. For example, should a ‘national’ program in Canada focus on the metropolitan areas around cities represented by the Big City Mayors’ Caucus, or include other regions as well?

WHAT ARE THE OPTIONS FOR FINANCING THE PROGRAM?

The international precedent is generally for the majority of funding/investment to come from national (or EU) government sources. In the short to medium term, investing in a ‘NISP-Canada’ is an attractive value proposition for policy makers /governments who are already investing significant amounts to achieve the combined aims of job creation, growth, innovation, competitiveness, and greenhouse gas emission reduction.

Long-term, it is not likely politically palatable for a NISP-Canada to be primarily funded by the federal government. Long term funding will be greatly influenced by the results of any pilot. For example, it’s possible that, like Belgium, certain sectors see great success and those associations are therefore incentivized to fund the program long term. Alternative finance mechanisms should also be explored, such as green bonds, social impact bonds, and the establishment of a trust into which a portion of companies’ savings from implementing symbiosis could be deposited and used to sustain the program. The European Commission’s Directorate General for the Environment commissioned a report in 2011 that, while endorsing the NISP model, did note that scaling could be affected by limited funds (Economic Analysis of Resource Efficiency Policies, 2011, see also Appendix G). Should Canada be able to develop some alternative funding models, there would likely be significant international interest in learning from and adapting these models to other NISP initiatives.
It should also be noted that, to secure government funding, both the Canadian and provincial contexts would likely require NISP to be housed within a not-for-profit entity. However, this should also be confirmed during any pilot.

**HOW DO THE BENEFITS SEEN IN THE UK SCALE TO A CANADIAN REGION?**

And what might that mean for benefits in other regions in Canada? The geographic, regulatory, and economic landscape is not only unique at the national scale, but also varies regionally as well. It’s not known how the benefits scale to regions with less heavy industry, or what the influence is, if any, of policies such as a carbon tax or strong extended producer responsibility legislation.

In conclusion, while it is most certainly feasible to apply the NISP model in the Canadian context, there are some considerations that may shape the final form of any NISP-Canada. Regional pilots would help to answer outstanding questions. The answers to these questions will: maximize the success of a regional model; shape a sustainable, multi-region “Made-in-Canada” program; and provide yet another valuable case study to the growing number of countries exploring how best to adopt NISP to meet their national and local sustainable business objectives.
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APPENDIX A

Workshop Outcome Report
APPENDIX B

South Africa:
Breakdown of data and achievements
APPENDIX C

Case Studies
APPENDIX D

NISP Economic Valuation Report, 2009
Pathway to a Low Carbon Sustainable Economy, 2010
APPENDIX E

Green Game-Changing Innovation:
New Business Thinking From Around the World, 2010
APPENDIX F

Global Green Growth Forum (3GF):

3GF Partnership – Industrial Symbiosis
Partnership session summary- Industrial Symbiosis
Improving Resource Efficiencies in the Value Chain
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Economic Analysis of Resource Efficient Policies, 2011
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G7 Alliance for Resource Efficiency: Workshop on Industrial Symbiosis 29/30 October 2015